SP212 FINAL EXAM

11 MAY 1999

GREEN

NAME ______________________________

ALPHA ______________________________

PREFIXES

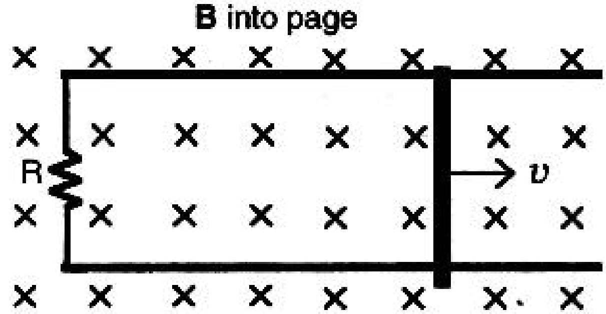
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^2	centi	c

10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

DIRECTIONS: Using a #2 pencil, fill out the information boxes on the front of the scan sheet as instructed by your instructor. On this sheet should be your alpha code, section number, name, and your instructor's name. Also, there are two versions of the exam, a GREEN version and a BLUE version. You have the GREEN version so for item **41** on the scan sheet you should mark response **(a)**. It is recommended that you postpone transferring your answers to the scan sheet until you have completed the exam. That way you are less likely to have to make erasures on the scan sheet. There are 40 multiple choice items. For each item choose the response that **best** completes the statement. You may use a formula sheet and a calculator to assist you. Before leaving you must turn in your exam booklet with you name and alpha code on it, your formula sheet, and any scratch paper used. The scratch paper is to be placed inside the exam booklet.

1. A conducting bar moves on rails to the right with constant velocity v as shown, and the uniform, constant magnetic field **B** is directed into the page. This results in a current in the circuit and energy being dissipated in the resistor.

The energy being dissipated in the resistor comes from:

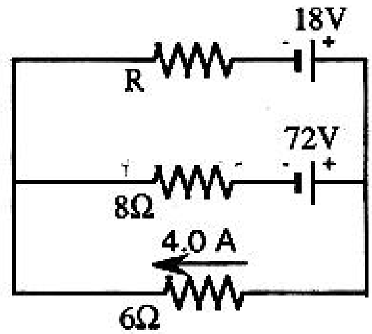


A. the uniform, constant magnetic field **B**
B. the external agent that is pushing the bar
C. the kinetic energy of the moving bar
D. a non conservative electric field
E. the inertia of the conduction electrons in the resistor

2.

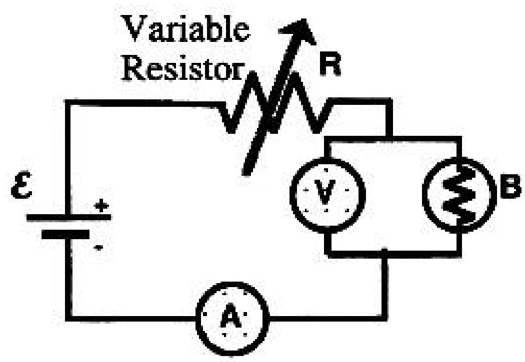
In the circuit shown the batteries are ideal.

We can conclude that the current through the 18 ~~6.0~~ V battery is



A. 1.5 A to the left
B. 1.5 A to the right
C. 2.0 A to the left
D. 2.0 A to the right
E. 2.5 A to the left

3. The circuit shown was wired with the purpose of measuring the resistance of the light bulb B. Inspection shows that:



A. voltmeter V and variable resistor (rheostat) R should be interchanged
B. the circuit is satisfactory
C. the voltmeter V should be in parallel with R, not the bulb B
D. the meters, V and A, should be interchanged
E. bulb B and ammeter A should be interchanged

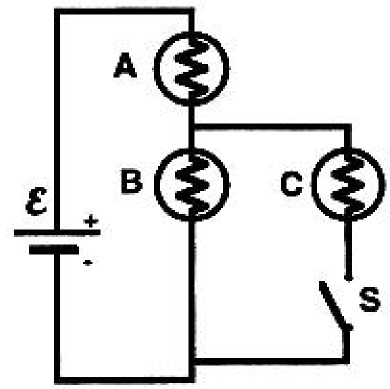
4. In a circuit powered by a battery, several resistors are connected in series.

   A. The voltage drop across each of these resistors is the same.
   B. The current in each of these resistors is the same.
   C. The power dissipated in each of these resistors is the same.
   D. The voltage drops across these resistors algebraically sum to zero.
   E. The algebraic sum of the currents in each of these resistors is zero.

5. In a circuit powered by a battery, several resistors are connected in parallel.

   A. The voltage drop across each of these resistors is the same.
   B. The current in each of these resistors is the same.
   C. The power dissipated in each of these resistors is the same.
   D. The voltage drops across these resistors algebraically sum to zero.
   E. The algebraic sum of the currents in each of these resistors is zero.

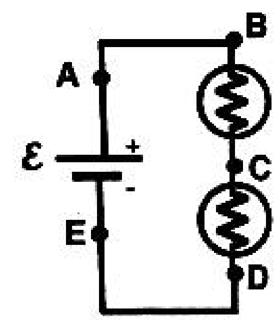
6. In the circuit shown the light bulbs are *identical*, the battery is *ideal*, and the switch **S** is *initially open*.



When the switch **S** is *closed*:

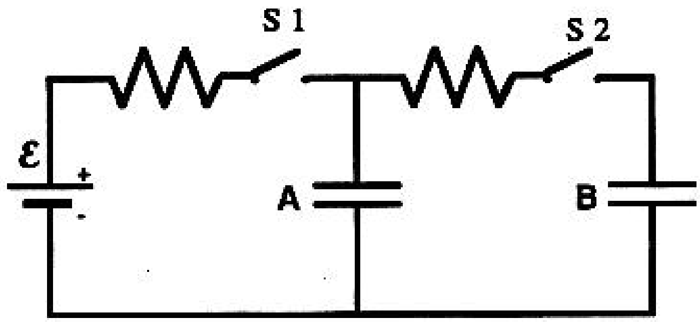
   A. **bulb A** gets brighter and **bulb B** gets dimmer
   B. **bulb A** gets brighter and **bulb B** goes out
   C. **bulb A** gets dimmer and **bulb B** gets brighter
   D. both **bulb A** and **bulb B** get dimmer
   E. both **bulb A** remains the same and **bulb B** get dimmer

7. In the circuit shown, the current:



   A. at **A** is larger than the current at **B**
   B. at **A** is smaller than the current at **C**
   C. at **C** is larger than the currents both at **A** and at **B**
   D. at E equals the current at **D**, and is less than the current at **A**
   E. is the same at **A, B, C, D,** and **E**

8. Identical capacitors **A** and **B** are initially without charge. Switch **S1** is then closed and capacitor **A** becomes charged. When it is fully charged it stores **4 J** of energy. Next, switch **S1** is opened and then switch **S2** is closed.

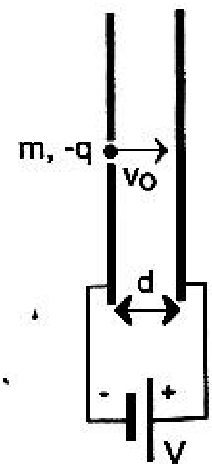


When the current becomes zero *energy* stored in each capacitors is:

A. 1 J
B. 2 J
C. 4 J
D. 8 J
E. 16 J

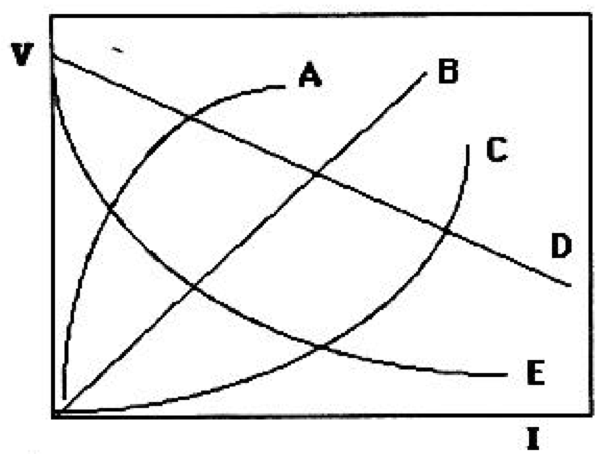
9. A particle (mass ***m***, charge -**q**) is projected with speed v_o into the region between two parallel conducting plates as shown. The separation of the plates is ***d***, the potential of the rightmost plate is higher than that of the leftmost plate by the battery voltage V.

The *change* in *kinetic energy* of the particle as it traverses this region is:



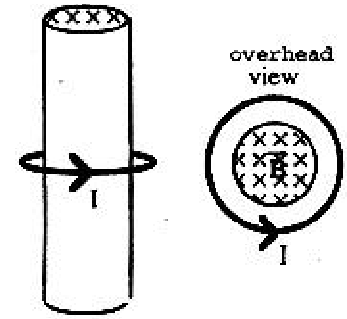
A. $2qV / m v_o^2$ B. $- qV / d$ C. $q(V - v_o)$ D. $- qV$ E. $+qV$

10. When the *potential V* across a piece of material is plotted **vs** the *current* through it, the curve which *best* represents the behavior of an *ohmic material* at constant temperature is:



A. A B. B C. C D. D E. E

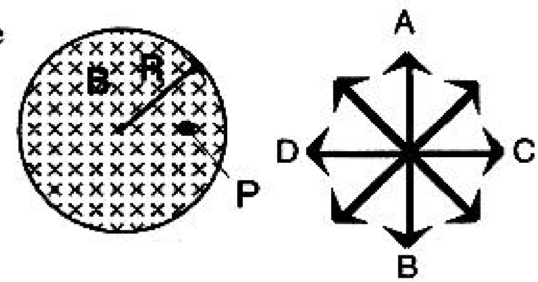
11. A long thin solenoid has a *radius* of **0.040 m** and current that is *increasing linearly* with time. The time rate of change of the magnetic field inside the solenoid is **0.50 T/s**. A circular loop of wire with a radius of **0.080 m** and a resistance of **0.050 Ω** surrounds the solenoid, as shown.



The *emf* induced in the loop is:

A. 2.51×10^{-3} V
B. 3.62×10^{-4} V
C. 7.89×10^{-4} V
D. 1.46×10^{-5} V
E. 3.33×10^{-5} V

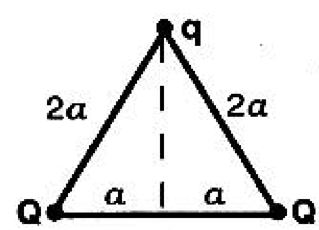
12. The figure shows the magnetic field **B** inside a long solenoid of radius R. The magnetic field, directed into the page, is increasing in magnitude at a steady rate. This changing magnetic field produces a non conservative electric field **E**.



At point P, the direction of **E** is:

A. in the direction of the arrow labeled A
B. in the direction of the arrow labeled B
C. in the direction of the arrow labeled C
D. in the direction of the arrow labeled D
E. directed into the page

13. The two charges **Q** are fixed at the vertices of an *equilateral triangle*. Each side of this triangle has length $2a$.



The force exerted on **q** by the other two charges is

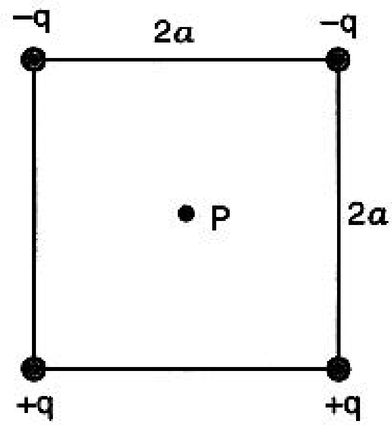
$$bk_e \frac{Qq}{a^2}$$

where b equals

A. 0.250
B. 0.433
C. 0.500
D. 2.67
E. 4.00

14. Four point charges are located at the corners of a square as shown. Each edge of the square has a length of $2a$.

The *magnitude* of the electric field at point P at the square's center is:



A. $\sqrt{2}\,k_e \dfrac{q}{a^2}$

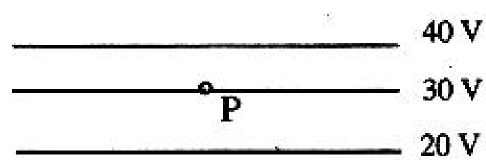
B. $k_e \dfrac{q}{a^2}$

C. $\sqrt{2}\,k_e \dfrac{q}{2a^2}$

D. $k_e \dfrac{q}{2a^2}$

E. $k_e \dfrac{q}{4a^2}$

15. Three equipotential surfaces are sketched to the right. At point P, the direction of $\vec{E}$ is most nearly that of:



A. $\rightarrow$ B. $\leftarrow$ C. $\uparrow$ D. $\downarrow$ E. $\odot$

16. Two point charges, q_1 and q_2, are placed a distance d apart. It is found that the electric field intensity is *zero* at some point **P** located *between* the charges and lying on the line segment connecting them. It follows that:

A. q_1 and q_2 *must have* the same magnitude and sign

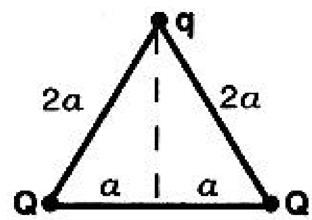
B. P *must be* midway between q_1 and q_2

C. q_1 and q_2 *must have* the same sign but may have different magnitudes

D. q_1 and q_2 *must have* equal magnitudes and opposite signs

E. q_1 and q_2 *must have* opposite signs but may have different magnitudes

17. Two particles, each of charge +Q, are separated by a distance 2a. A third charge q is located at the vertex of the equilateral triangle as shown. The *work* required to move charge q from the vertex to the center of the line joining the fixed charges is:



A. zero B. $\frac{kQq}{a^2}$ C. $\frac{kQq}{a}$ D. $\frac{2kQq}{a}$ E. $\frac{\sqrt{3}kQq}{2a}$

18. The outer surface of a thin cylindrical shell is uniformly charged with a surface charge density of $10.0\,nC/m^2$. If the shell's radius and length are 0.100 m and 0.400 m, respectively, the net charge on its outer surface is:

A. 12.3 nC
B. 9.22 nC
C. 4.66 nC
D. 2.51 nC
E. 0.277 nC

19. Two completely discharged capacitors that are not identical are connected in series, and this series combination is then connected across the terminals of a battery. When the current stops, the quantity that is the same for both capacitors is:

A. potential difference
B. stored energy
C. energy density
D. electric field
E. charge on the positive plates

20. A point charge q is placed at the center of a spherical gaussian surface. The electric flux Φ_E through the surface will change if:

A. the radius of the surface is doubled.
B. the shape of the surface is changed to a cube with the same volume as the original sphere.
C. the point chrage is moved off center (but still inside the sphere).
D. the point charge is moved to a location just outside the sphere.
E. if a second point charge is placed just outside the sphere.

21. A charge of **+10 C** is placed *on* a spherical conducting shell. In addition, a **+3 C** point charge is placed at the *center* of the shell's cavity. The *net charge* on the *outer* surface of the shell is:

A. -7 C
B. -3 C
C. +7 C
D. +10 C
E. +13 C

22. The slits of a Young's double slit apparatus are separated by a distance of **500 μm.** A screen is located **4 m** from the plane of the slits. When light of wavelength **500 nm** illuminates the slits, the distance *on the screen* between the *central* bright fringe and the *fourth* bright fringe on either side is:

A. 4 mm
B. 8 mm
C. 12 mm
D. 16 mm
E. 32 mm

23. A thin wedge of air is formed between two glass plates. When it is normally illuminated with light of *wavelength* **560 nm,** and is viewed in reflected light, the film shows parallel interference fringes (bright and dark bands).

For adjacent dark fringes, the difference in thickness of the air wedge is:

A. 140 nm
B. 280 nm
C. 420 nm
D. 560 nm
E. 700 nm

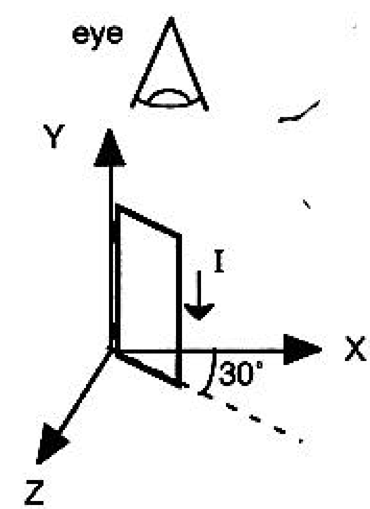
24. Shortly after a rain you shine a laser beam up through a glass skylight on the roof of your house. A thin film of water remains on the outside surface of the glass. The index of refraction of the glass is 1.5 and that of the water is 1.33. Light is reflected at both the glass-water surface and the water-air surface. The reflected light is phase shifted by 180°:

A. at the glass-water surface only
B. at thethe water-air surface only
C. at both the glass-water surface and the water-air surface
D. at neither the glass-water surface nor the water-air surface
E. at neither surface. However, it is shifted by 90° at both surfaces

25.

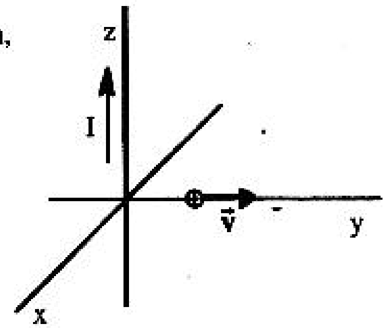
A current of **3 A** flows through a **40-turn** rectangular coil in the direction shown. The 0.20-m by 0.10-m coil is hinged along the y axis, its base making a 30° angle with the x axis. The coil is in a *uniform* 1.20-T magnetic field in the positive z direction.

As viewed by the eye shown in the figure, the *torque* on the coil is:



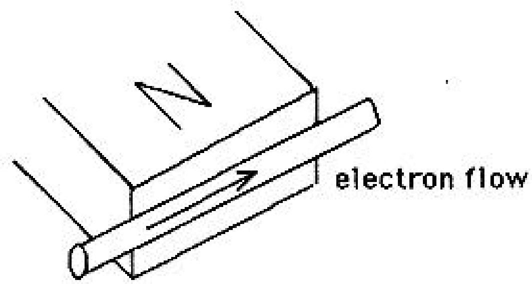
A. 1.26 N·m, counterclockwise
B. 1.26 N·m, clockwise
C. 1.44 N·m, clockwise
D. 1.86 N·m, counterclockwise
E. 2.49 N·m, counterclockwise

26. A long *straight* wire carries a current **I** in the **+z** direction, and this current produces a magnetic field. A proton moves along the **y - axis** with a speed **v**. The direction of the *magnetic force* on the proton is:



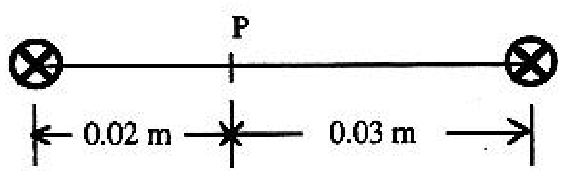
A. +y B. +z C. -x D. -y E. -z

27. The figure shows the motion of *electrons* in a wire which is near the *N pole* of a magnet. The wire will be pushed:



A. toward the magnet
B. away from the magnet
C. downwards
D. upwards
E. along its length

28. Two long straight wires **0.050 m** apart carry equal currents of **15 A** *into* the paper, as shown. Point **P** is between the two wires, **0.020 m** from one wire and **0.030 m** from the other.



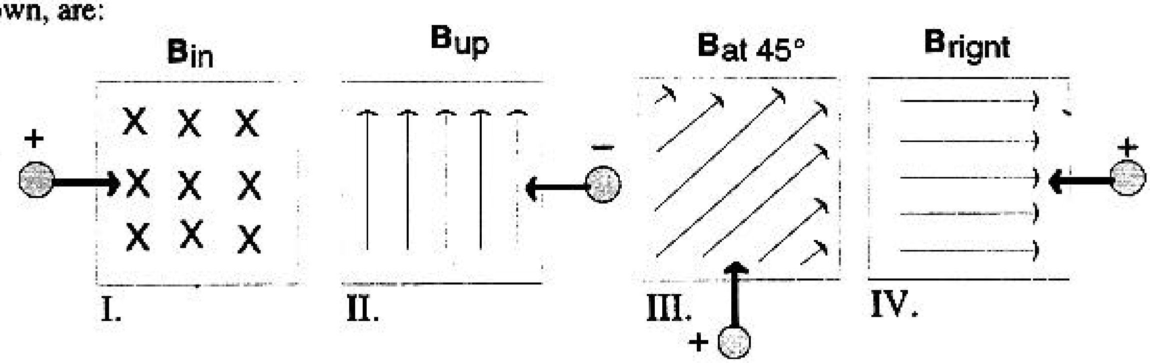
At **P** the *magnitude* of $\vec{\mathbf{B}}$ is:

A. 50 μT
B. 100 μT
C. 150 μT
D. 180 μT
E. 250 μT

29. A *concave* spherical mirror has a *radius of curvature* of **2.0 m**. If an object is placed **3.0 m** in front of the mirror, the reflected light will form an image:

A. more than 4.0 m behind the mirror
B. more that 1.0 m but less than 4.0 m behind the mirror
C. less than 1.0 m behind the mirror
D. less than 1.0 m in front of the mirror
E. more than 1.0 m in front of the mirror

30.
The initial direction of the deflection of the charged particles as they enter the magnetic fields, as shown, are:



Remark: $\otimes$ denotes into the page, $\odot$ denotes out of the page, and "null" denotes no deflection

A.
I. $\otimes$
II. null
III. ↑
IV. →

B.
I. $\odot$
II. ↓
III. $\otimes$
IV. →

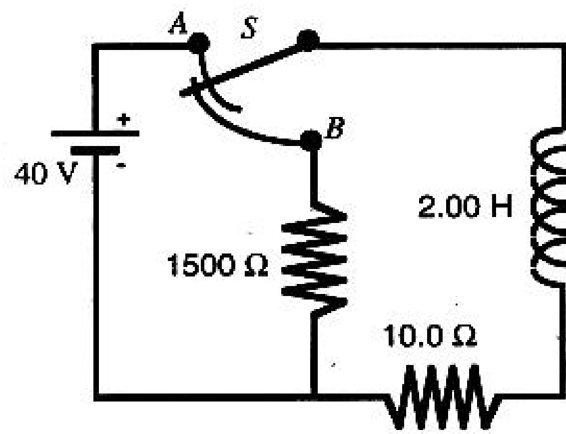
C.
I. ↑
II. $\odot$
III. $\otimes$
IV. null

D.
I. ↓
II. $\odot$
III. ↖
IV. null

E.
I. ↑
II. $\otimes$
III. $\odot$
IV. →

31.
The switch in the circuit shown has been in position *A* for a long time. Then, it is quickly thrown from *A* to *B*.

The voltage across the inductor *just after* the switch is moved to *B* is:

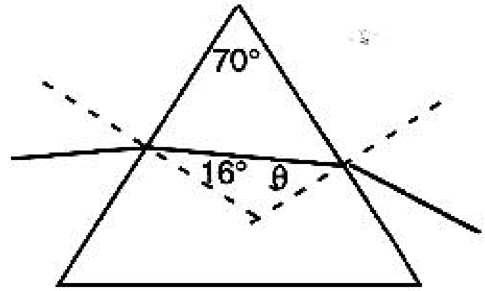


A. zero
B. 20.0 V
C. 40.0 V
D. 283 V
E. 601 V

32. You are in the barber shop where there are large flat mirrors on two opposite walls. The mirrors are separated by 6.0 m, and the barber chairs are 2.0 m from one of them. You are sitting in a barber chair and, believe it or not, Leonardo DiCaprio is sitting in the barber chair next to yours. You are looking into the far mirror at the images the fair-haired Leo. How far from him is the second closest image?

A. 6.0 m
B. 8.0 m
C. 10 m
D. 12 m
E. 14 m

33. A glass prism with an index of refraction of 1.50 has a apex angle of 70° as shown. A light ray in air is incident on the prism. Upon entering the glass the refracted ray makes an angle of 16.4° with the normal.



The angle of incidence θ that the ray makes at the opposite face of the prism is:

A. 27°
B. 46°
C. 54°
D. 57°
E. 60°

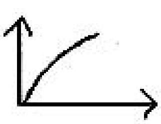
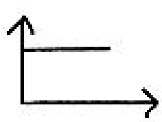
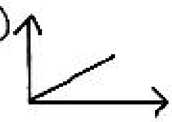
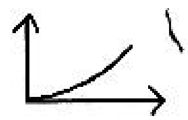
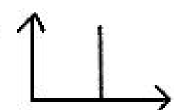
34. A polarized beam of light is incident (at normal incidence) upon a stack of three ideal polarizing sheets. The transmission axis of the first sheet is rotated 30° clockwise from the plane of polarization of the incident beam, the transmission axis of the second sheet is rotated30° clockwise from the direction of the transmission axis of the second sheet, and so fourth. Consequently, the transmission axis of the third sheet is rotated 90.0° clockwise from the plane of polarization of the incident beam.)

The intensity of the incident beam is 100 W/m^2. The intensity of the beam that is transmitted through all [redacted] sheets is: three

A. zero
B. 4.3 W/m^2
C. 14.3 W/m^2
D. 42.2 W/m^2
E. 56.6 W/m^2

35. An initially uncharged capacitor in a complex circuit. During a 20.0-s interval it is charged via a *constant* current. During this interval, the graph that correctly gives the charge Q on the positively charged capacitor plate as a function of time is:

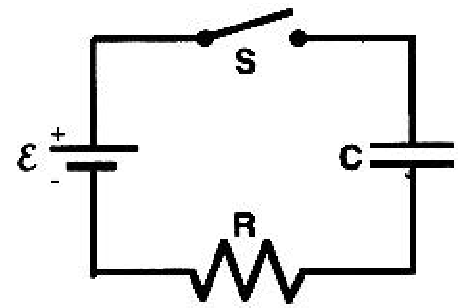
Remark: On each graph, Q is on the vertical axis and time is on the horizontal axis.

A.  B.  C.  D.  E. 

36. Light propagating in glass of index of refraction **1.65** is incident at **50°** on a boundary surface with water (**n = 1.33**). The *angle of refraction* of the light entering the water is

A. 72°
B. 62°
C. 40°
D. 38°
E. non-existent, since no light enters the water, the angle of incidence being greater than the critical angle for total reflection.

37. In the circuit shown $\mathcal{E} = 10.0$ V, $C = 25.0 \times 10^{-3}$ F, and $R = 1.00 \times 10^{3}\,\Omega$. Initially, the switch S is open and the capacitor plates are without charge. The switch is then closed.



At the instant the charge on the positively-charged capacitor plate is 200×10^{-3} C, the current through the resistor is:

A. 1.00×10^{-4} A
B. 2.50×10^{-4} A
C. 5.00×10^{-4} A
D. 7.50×10^{-4} A
E. 2.00×10^{-3} A

38. A small fish is at the center of a water-filled spherical bowl of radius **25 cm**. Use **n = 1.33** for water. Fluffy the cat is looking into the bowl from the side.

She will see an image of the fish:

A. 10 cm closer to her than the bowl's center
B. 5.0 cm closer to her than the bowl's center
C. at the center of the bowl
D. 5.0 cm further from her than the bowl's center
E. 10 cm further from her than the bowl's center

39. When a beam of light traveling in air enters a piece of glass, the light undergoes a change in:

A. speed only.
B. frequency only.
C. wavelength only.
D. speed and frequency.
E. speed and wavelength.

40. Light travels in medium 1 with a speed of **240×10^{6} m/s**. It then enters medium 2 where it travels at a speed of **125×10^{6} m/s**. The *ratio* of the *index of refraction* of medium 1 to that of medium 2 is:

A. 0.033
B. 0.521
C. 1.25
D. 1.93
E. 2.40

41. If your test is printed on GREEN paper mark response A. If it is printed on BLUE paper mark response B.
A. GREEN B. BLUE C. D. E.